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EXAMINER	
FISCHER, JUSTIN R	

ART UNIT	PAPER NUMBER
1791	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/781,314	XU, YOUZHI E.	
	Examiner	Art Unit	
	Justin R. Fischer	1791	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _19 May 2009_.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _16-22 and 24-30_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _16-22 and 24-30_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. <u>Claims 16, 17, 19-22, 24, 27, 28, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mertol (US 6,008,536, of record) and further in view of Moeller (DE 19751463, of record)</u>.

Mertol teaches an assembly comprising an integrated circuit 12 (heat generating device), a first thermal interface material 36 comprised of a heat curable epoxy, and a heat spreader 16 (heat dissipating device) (Column 8, Lines 22+). The reference further teaches that the heat spreader is formed of a thermally conductive material, such as metals (Column 6, Lines 9+). It is further noted that the particular method in which the polymer is applied is related to the manufacturing method and does not further define the claimed structure of the claimed apparatus/system. The reference, however, is silent as to the presence of covalent bonds between the thermal interface material and the heat sink.

Moeller, on the other hand, is directed to a method of improving adhesion between a metal surface and a heat curable resin/adhesive, such as epoxy, by including a specific additive or hardener system- in such a technique, a covalent bond is formed between the heat curable resin and the metal surface. One of ordinary skill in the art at

the time of the invention would have found it obvious to use such a technique in the method of Mertol since it provides improved adhesion between a metal surface and a heat curable resin, such as epoxy.

Lastly, with respect to the independent claim, the polymer of Mertol is described as being a thermally conductive polymer and it is unclear how such a polymer cannot be viewed as an electroactive polymer (Column 8). It is emphasized that the claim language does not require a polymer with electroactive end groups (represents an exemplary electroactive polymer).

Regarding claim 19, the interface material of Mertol comprises an epoxy matrix and conductive filler particles (e.g. silver) and such a composition is seen to constitute a molecular composite material.

With respect to claim 20, conductive filler particles having a wide variety of particle sizes and distributions are commonly used in thermal interface materials. One of ordinary skill in the art at the time of the invention would have found it obvious to use small and/or large filler particles and it appears that the claim language is directed to extremely smaller filler particles. Also, applicant has not provided a conclusive showing of unexpected results to establish a criticality for the claimed invention.

As to claim 22, the apparatus/system of Mertol, in view of Moeller, includes a thermal interface material comprising an epoxy matrix and a thermally conductive filler, wherein said interface material would be covalently bonded to a metal heat spreader. A fair reading of the Mertol suggests the general use of a conductive epoxy material- such a disclosure suggests the use of a wide variety of epoxies, including those having a

thermal conductivity greater than 4 W/mK and applicant has not provided a conclusive showing of unexpected results to establish a criticality for the claimed conductivity.

With respect to claims 27, 28, and 30, Mertol describes the claimed flip chip assembly (Column 3, Lines 25+).

3. Claims 16, 17, 19-22, 24-28, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith (US 20010052652, of record) and further in view of Miyao (JP 4-364764, of record) and Moeller.

As best depicted in Figure 1, Smith teaches an assembly comprising a heat generating device 12, a first thermal interface material 14, a heat spreader 13, a second thermal interface material 16, and a heat sink 20. The reference further teaches that the interface materials comprise an epoxy matrix and conductive fibers, wherein said fibers have a thermal conductivity of at least 25 W/mK (Paragraphs 26 and 28). Furthermore, the particular method in which the polymer is applied is related to the manufacturing method and does not further define the claimed structure of the claimed apparatus/system.

In regards to the heat sink, Smith is completely silent to the material used to form said heat sink. However, it is well known to form such heat sinks from thermally conductive materials, including metals (e.g. iron), as shown for example by Miyao. As such, one of ordinary skill in the art at the time of the invention would have found it obvious to form the assembly of Smith with a metal heat sink. In this assembly, the metal heat sink is directly adjacent a thermal interface material comprised of a thermal epoxy. It is emphasized that heat dissipating devices, in general, are formed of

conductive metals or metal alloys and thus, one of ordinary skill in the art at the time of the invention would have similarly found it obvious to form the heat spreader of Smith from metal and perform the aforementioned oxidizing step.

The combination of references, however, does not expressly describe the presence of covalent bonds between the metal heat spreader and the epoxy interface material. Moeller, however, teaches a method of improving adhesion between a metal surface and a heat curable resin/adhesive, such as epoxy, by including a specific additive or hardener system- in such a technique, a covalent bond is formed between the heat curable resin and the metal surface. One of ordinary skill in the art at the time of the invention would have found it obvious to use such a technique in the method of Smith since it provides improved adhesion between a metal surface and a heat curable resin, such as epoxy.

Lastly, with respect to the independent claim, it is unclear how the claimed polymers, such as an adhesive, cannot be viewed as an electroactive polymer. For instance, although recognized as generally being insulating, epoxies have some degree of electrical conductivity (although extremely small) and conductive polymers represent a class of electroactive polymers.

As to claim 19, a composition of epoxy and conductive fibers is seen to constitute a molecular composite material.

With respect to claim 20, conductive fibers having a diameter of 10 microns can be used in the interface material of Smith and such an assembly is seen to define a nanocomposite material.

Regarding claims 27, 28, and 30, the claimed flip chip method represents one of the most common electronic packages in which an integrated circuit is attached to a printed circuit board. One of ordinary skill in the art at the time of the invention would have recognized the generic language of Smith as including the claimed flip chip assembly.

4. Claims 16-22 and 24-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith and further in view of Jiang (US 6,812,064, of record).

As detailed in the previous paragraph, Smith substantially teaches the claimed system, including a heat generating device (integrated circuit comprised of semiconductor dies), a first thermal interface material (e.g. epoxy), a heat spreader, a second thermal interface material (e.g. epoxy), and a heat sink. While the reference fails to expressly disclose the makeup of the integrated circuit, it is extremely well known and conventional to form such components from silicon (taken to be admitted prior art since previous presented and unchallenged by applicant). The reference, however, is silent as to the presence of covalent bonds between the silicon surface of the integrated circuit and the epoxy thermal interface material.

Jiang, however, is directed to a method of improving the adhesion between an epoxy adhesive/interface material and a silicon semiconductor die by oxidizing the silicon surface (produces some hydroxyl residues or functional groups) (Column 4, Lines 25+). One of ordinary skill in the art at the time of the invention would have found it obvious to oxidize the silicon semiconductor die (and include a coupling agent in the adhesive layer) of Smith for the reasons detailed above. It is further noted that

applicant recognizes such a method (oxidizing silicon substrate) as forming covalent bonds between the silicon substrate and the epoxy interface material (see Paragraph 24 of ordinal disclosure).

Lastly, with respect to the independent claim, it is unclear how the claimed polymers, such as an adhesive, cannot be viewed as an electroactive polymer. For instance, although recognized as generally being insulating, epoxies have some degree of electrical conductivity (although extremely small) and conductive polymers represent a class of electroactive polymers.

As to claim 19, a composition of epoxy and conductive fibers is seen to constitute a molecular composite material.

With respect to claim 20, conductive fibers having a diameter of 10 microns can be used in the interface material of Smith and such an assembly is seen to define a nanocomposite material.

Regarding claims 27, 28, and 30, the claimed flip chip method represents one of the most common electronic packages in which an integrated circuit is attached to a printed circuit board. One of ordinary skill in the art at the time of the invention would have recognized the generic language of Smith as including the claimed flip chip assembly.

Response to Arguments

5. Applicant's arguments filed May 19, 2009 have been fully considered but they are not persuasive.

Applicant argues that Mertol is silent with respect to a thermal interface material comprising an electroactive polymer. Applicant further argues that examples of electroactive polymers include hybrid polymers having electroactive end groups, such as NH_n^+ or COO^-.

As acknowledged by applicant, the thermal interface material of Mertol can be a conductive epoxy compound. It is unclear how such "conductive" compounds cannot be viewed as being electroactive compounds. It is emphasized that the examples noted by applicant above are exemplary and it is not required that the polymer of Mertol have electroactive end groups. This is particularly evident in view of Pelrine (US 6,809,462, of record), which recognizes the wide variety of materials that can be viewed as "electroactive polymers" (Column 16, Lines 20+).

Applicant further contends that Mertol and Moeller are silent with respect to a <u>covalent bonding of a thermal interface material</u> with either the heat generating or the heat dissipating device.

As detailed in the rejection above, the thermal interface material of Mertol is directly adjacent and contacts the heat dissipating device or heat sink. The reference further teaches that the thermal interface material is a heat curable material, such as an epoxy resin, and the heat sink is formed of a metallic material. Moeller, on the other hand, recognizes the inclusion of a specific hardner **<u>in a heat curable resin layer</u>**, such as an epoxy, in order to form covalent bonds with an adjacent metal layer and improve adhesion. It is emphasized that the hardener represents a component that forms the epoxy resin and thus represents part of the epoxy resin or thermal interface material.

Thus, the thermal interface material of Mertol (including specific hardener of Moeller) would be covalently bonded to the metallic heat sink.

It is further noted that while layer 40 is described as an “adhesive layer” and layer 36 is described as a "thermal interface material", the respective layers are formed of the identical material (Column 8, Lines 20+). It appears that layer 36 is characterized as a “thermal interface material” because that is the primary function of said layer. However, based on the same composition, it appears that high degree of adhesion would have been equally desired between the heat sink and the thermal interface material. As such, one of ordinary skill in the art at the time of the invention would have found it obvious to form the epoxy resin of Mertol with the specific hardner of Moeller and create covalent bonds between the resin and the metallic heat sink. Additionally, such a modification does not appear to interfere with the desired thermal conductivity properties (reasonable expectation of success).

Also, the fact that Moeller is silent with respect to a heat transfer process does not render the proposed modification unobvious. It is emphasized that Mertol and Moeller are extremely similar in that a heat curable resin, such as an epoxy, is directly adjacent and contacts a metallic layer and thus, one of ordinary skill in the art at the time of the invention would have been amply motivated to form covalent bonds in the structure of Mertol (such a modification does not appear to interfere with the desired thermal conductivity properties and there would be a reasonable expectation of success).

Applicant argues that Smith, Miyao, and Moeller are all silent with respect to a thermal interface material comprising an electroactive polymer. It is unclear, however, how the conductive polymer of Smith cannot be viewed as an electroactive polymer. As detailed above, the claims do not require polymers having electroactive end groups as they represent an exemplary form of electroactive polymers and are only referenced in the original disclosure (not included in claims). See Pelrine referenced above.

Applicant further argues that there is no one-to-one correspondence between adhesion bonding and thermal bonding. In this instance, however, the thermal interface material of Smith is specifically described as an adhesive material (Paragraph 28). Thus, improved adhesion between a thermal interface material or adhesive layer and an adjacent, metallic heat sink would be desired in the structure of Smith.

Applicant contends that there is no motivation to combine the art of Smith and Miyao (semiconductor packaging) and the art of Moeller (adhesion improvement of coating on a metallic surface). As detailed above, however, the respective references are directly analogous in that they pertain to assemblies including heat curable compositions, such as epoxies, directly adjacent metallic substrates. It is emphasized that the thermal interface material of Smith is expressly described as an "adhesive layer" and thus improved adhesion would be highly desirable.

Applicant further argues that the present claims disclose covalent bonds between a thermal interface material and a heat generating and/or a heat dissipating device "to improve thermal conduction from the heat generating device to the heat dissipating device". The fact that applicant has recognized another advantage which would flow

naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). It is emphasized that covalent bonds would be present in the modified structure of Smith in view of Moeller and any realized benefits in conductivity (by applicant) would be present in said modified structure.

Regarding Smith and Jiang, applicant argues that the references fail to describe a thermal interface material comprising an electroactive material. See arguments above and reference to Pelrine.

Applicant contends that Jiang is silent with respect to covalent bonding. Furthermore, applicant states that forming a covalent bond requires a preparation of both surfaces and simply oxidizing a silicon surface is not adequate to form a covalent bond with an epoxy material.

As best depicted in Figure 3C, however, the construction of Jiang does include covalent bonds between the surface of the semiconductor die and the underlying adhesive layer. Furthermore, the method of Jiang does not simply involve oxidizing the silicon surface. Jiang teaches the inclusion of a coupling agent in the adhesive layer, such that the silicon atoms of the semiconductor die are linked or covalently bonded to the silicon atoms of the adhesive layer (Column 4, Lines 25+).

It is further noted that integrated circuits, such as the one included in the assembly of Smith, are conventionally formed of silicon and Jiang specifically teaches a method of improving adhesion between adhesive layers, such as epoxy, and electrical components formed of silicon. As detailed above, the thermal interface material of

Smith is specifically described as being an adhesive layer and thus, improved adhesion would have been highly desirable in the assembly of Smith. Furthermore, the modification of Smith in view of Jiang would not be expected to interfere with the desire to remove excess heat formed by the integrated circuit (reasonable expectation of success).

Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Justin R. Fischer** whose telephone number is **(571) 272-1215**. The examiner can normally be reached on M-F (7:30-4:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Crispino can be reached on (571) 272-1226. The fax phone

number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Justin Fischer
/Justin R Fischer/
Primary Examiner, Art Unit 1791
June 23, 2009